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SKINNER LANDFILL
West Chester, Butler County, Ohio

Remedial Design

Final Design (100%)
Phase I Report

Volume I of IV

May 20, 1996

Prepared by:

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SKINNER LANDFILL SUPERFUND SITE
FINAL (100%) REMEDIAL DESIGN REPORT
WEST CHESTER, BUTLER COUNTY, OHIO

Rust Environment & Infrastructure of Ohio Inc.
PROJECT NO. 72680

May 20, 1996

Revision 0

Skinner Landfill
Remedial Design

Final (100%) Remedial Design

Prepared by: Rust Environment & Infrastructure of Ohio Inc., 11785 Highway Dr.. Suite 100, Cincinnati, Ohio 45241 on behalf of the Skinner Landfill PRP Group

Date: May 20, 1996

Approvals:

______________________________ Date ____________

Larry I. Bone, Ph.D.
PRP Group Technical Committee Chairman

______________________________ Date ____________

Edward C. Copeland
Technical Project Manager for
the PRP Group
Rust Environment & Infrastructure of Ohio Inc.

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Jamey Bell
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May 20, 1996

Mr. Jamey Bell, Remedial Project Manager
United States Environmental Projection Agency, Region V
Minnesota/Ohio Remedial Response Branch (HSRM-6J)
77 West Jackson Boulevard
Chicago, Illinois 60604
Attention: Section II-6J

Re: Skinner Landfill Site
West Chester, Butler County, Ohio
Final (100%) Remedial Design Report

Dear Mr. Bell:

On behalf of the Skinner Landfill PRP Group, Rust Environment & Infrastructure of Ohio Inc. (Rust) hereby submits two (2) copies of the Final (100%) Remedial Design report for the subject site.

If you have any questions, please contact me at (513) 483-5321.

Sincerely,

Edward C. Copeland

Edward C. Copeland, P.E., CHMM
Senior Environmental Engineer

c: Greg Youngstrom, OEPA
Kathy McClanahan, USACE, Nashville District (2 copies)
Sherry Estes, U.S. EPA w/o attachment
Bruce Sypniewski, U.S. EPA w/o attachment
Larry I. Bone, Ph.D. - Skinner Landfill PRP Group Technical Chairperson
Ed Need - Rust E&I

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LIST OF ACRONYMS

AMP	Air Monitoring Plan
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
BCDES	Butler County Department of Environmental Services
BZ	Breathing Zone
CD&D	Construction Debris and Demolition Waste
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CGI	Combustible Gas Indicator
CHSD	Corporate Health and Safety Director
CLP	Contract Laboratory Program
cm/sec	Centimeters Per Second
CO	Carbon Monoxide
CQA	Construction Quality Assurance
CQAC	Construction Quality Assurance Consultant
CRZ	Contamination Reduction Zone
CSDI	Contaminated Soils Design Investigation
CZ	Control Zone
DSW	Division of Surface Water (OEPA)
DSR	Division Safety Representative
EPA	Environmental Protection Agency
EZ	Exclusion Zone
FID	Flame Ionization Detector
FML	Flexible Membrane Liner (low density polyethylene)
FSP	Field Sampling Plan
ft	Feet
ft/sec	Feet Per Second
GCL	Geosynthetic Clay Layer
gpd	Gallons Per Day
gpm	Gallons Per Minute
GWDI	Groundwater Design Investigation
HAP	Hazardous Air Pollutant
HASP	Health and Safety Plan
HSM	Health and Safety Manager
IDLH	Immediately Dangerous to Life or Health
IRM	Interim Remedial Measures
kg/d	Kilograms Per Day
lb/day	Pounds Per Day
LEL	Lower Explosion Limit
LTPP	Long-Term Performance Plan
MSL	Mean Sea Level
NIOSH	National Institute for Occupational Safety and Health
NO_x	Oxides of Nitrogen
NWI	National Wetland Inventory
O_3	Ozone
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
OSHA	Occupational Safety and Health Administration
oz	Ounce
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PLC	Programmable Logic Controller
PM-10	Particulate Matter less than 10 microns
PRP	Potentially Responsible Party
PPE	Personal Protective Equipment
psi	Pounds Per Square Inch
QAPP (QAPjP)	Quality Assurance Project Plan

LIST OF ACRONYMS - CONT

RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RHSS	Regional Health & Safety Specialist
ROD	Record of Decision
SI	Site Inspection
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	Spill Prevention Control and Counter Measure Plan
SSO	Site Safety Officer
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SZ	Support Zone
TDH	Total Dynamic Head
TLV	Threshold Limit Values
TSS	Total Suspended Solids
TWA	Time Weighted Average
u	Micron
ug/l	Microgram per Liter
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VOC	Volatile Organic Compound
yr	Year
WBGT	Wet Bulb Globe Temperature
WZ	Work Zone

EXECUTIVE SUMMARY

This Final (100% complete) design submittal meets the requirements of the Statement of Work Section III.b.3 in that it provides the design of the remedial components and the basis for these elements. The following paragraphs provide a summary of the design development.

The groundwater interception system will be designed to consist of two components. A cut-off wall will be used in areas of low hydraulic conductivity to reduce the transfer of groundwater both into and out of the CERCLA site. It will consist of a low permeability soil-bentonite slurry installed from two to three feet below ground surface into the top of bedrock, creating a barrier curtain to groundwater transport. An interceptor trench will be installed in areas of higher hydraulic conductivity that will allow relatively free flow of groundwater into and through the trench. The interceptor trench will be constructed of gravel from two to three feet below ground surface to a level approximately four feet below major sand/gravel seams. Sumps will be installed in the low points of the interceptor trench and the groundwater will be pumped out of the trench. In some areas, a combination cut-off wall and groundwater interceptor trench will be used to capture and minimize dilution. The trench system will roughly run parallel to the East Fork of Mill Creek, effectively intercepting groundwater flow from the landfill area.

The collected groundwater from the interceptor trench will be discharged to a sanitary sewer located on site. This sewer transports wastewater to the Upper Mill Creek Waste Water Treatment Plant. Initial comparison of the anticipated discharge concentration of contaminants with the discharge criteria for the Butler County Department of Environmental Services (BCDES) indicates that the extracted groundwater can be discharged without treatment. A permit application has been submitted to BCDES, and the application is pending. If BCDES does not allow discharge, a backup system for discharge to the East Fork of Mill Creek has tentatively been designed.

The Statement of Work (SOW) requires an engineered cover system be designed and installed over the landfill area to reduce precipitation infiltration, control gas migration, and reduce potential for exposure to contaminated materials. The cover system, or cap, has been designed to achieve these performance objectives. The SOW provided specific components of construction of the cap; however, further review during the design indicate some modifications should be made to enhance constructability and therefore long-term viability of the design.

Based upon analysis of constructability, the burrowing animal protection layer has been deleted and a program of monitoring and capture will be implemented. The drainage and gas venting layers were to be constructed of sand according to the SOW. The design calls for use of synthetic geocomposites to improve drainage performance and reduce the volume of truck traffic into the site. The number of trucks required to bring in off-site material is also a reason for modifying the clay barrier layer described in the SOW. The 24-inch-thick, clay layer will be replaced by a Geosynthetic Clay Liner (GCL) and 18 inches of clay. The thickness of vegetative cover will be modified to provide a minimum 30-inches of cover over the clay barrier layer for frost protection. Equivalency of these alternative design elements to those specified in the SOW has been demonstrated.

The SOW also called for certain supporting documentation to be provided as part of the Prefinal Design submission. Included in this document are a Contracting Strategy Plan, Remedial Action Work Plan, Cost Estimate for Remedial Action Plan, Quality Assurance Project Plan, Field Sampling Plan, Health and Safety Plan, Spill Prevention Control and Countermeasure Plan, Air Monitoring Plan, Contingency Plan, Long-Term Performance Plan, Construction Quality Assurance Plan, Draft Operation and Maintenance Plan and Project Schedule.

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1.0

1.0 INTRODUCTION

This document presents the Final (100%) design of remedial measures for the Skinner Landfill Superfund Site (Skinner Landfill), located in West Chester, Butler County, Ohio. The following sections provide general information about the site, site history, and an overview of the structure of this Remedial Design Report.

1.1 General

This Remedial Design (RD) has been prepared in accordance with the Administrative Order on Consent (AOC) for the Skinner Landfill Site between the United States Environmental Protection Agency (U.S. EPA) and the Skinner Landfill PRP Group, dated March 29, 1994. The AOC, Statement of Work (SOW), and attachments present the selected remedial actions for the site and the requirements for design of the selected remedies. The RD has been prepared to provide details and construction requirements to allow for implementation of the remedial actions.

The remedial design as outlined in the SOW consists of several parts. These are:

a. Fencing
b. Institutional Controls
c. Landfill Cover
d. Downgradient Groundwater Control
e. Upgradient Groundwater Control
f. Soil Vapor Extraction
g. Monitoring and Testing of:

    1. Groundwater,
    2. Surface water,
    3. Air,
    4. Compliance Boundaries,
    5. Radiological Monitoring, and
    6. Soil and Wastes.

Many of these elements have been covered in separate submittals. Fencing was installed in 1993 and is currently being maintained through bi-weekly inspections. Pursuant to the December 9. 1992 Unilateral Administrative Order, monitoring and testing of the groundwater and surface water has been conducted as part of the Interim Remedial Measures (IRM) and will continue in accordance with an approved Work Plan. The IRM groundwater monitoring program has been conducted quarterly at six wells since July 6, 1993. Results have indicated sporadic and spatially variable detections of contaminants. Surface water sampling was conducted between April 1994 and April 1995. The purpose of the surface water sampling was to establish background conditions of the East Fork of Mill Creek. Also in accordance with the requirements of the AOC, a RD Work Plan for completion of these activities was prepared by the PRP's on August 25, 1994 and approved by the

United States Environmental Protection Agency (U.S. EPA) on September 23, 1994. A report evaluating the feasibility of SVE was submitted to U.S. EPA, on September 6, 1995. U.S. EPA agreed with the finding of that report, that SVE is not a viable process at the Skinner Landfill site.

The SOW required the performance of certain site investigations. These investigations were the Groundwater Design Investigation (GWDI) and Contaminated Soils Design Investigation (CSDI). U.S. EPA approved the GWDI and CSDI Reports on June 27, 1995, and these two documents are incorporated into the RD by reference.

This Final Remedial Design report consists of several primary design elements. The first element of the design is downgradient groundwater control via installation of a groundwater interception system. The second element is the controlled discharge of the collected groundwater. The third design element is a landfill cover that meets or exceeds the substantive requirements of RCRA Subtitle C. A fourth part of this remedial design is the generation of supporting plans, including a a quality assurance project plan, a field sampling plan, a health and safety plan, a spill prevention control and countermeasure plan, an air monitoring plan, a contingency plan, a long term performance plan, and an institutional controls strategy.

1.2 Site Location and Description

The Skinner Landfill Site is located approximately 15 miles north of Cincinnati, Ohio near the City of West Chester, Butler County, Ohio, Township 3, Section 22, Range 2. The site is located along Cincinnati-Dayton Road as shown in Figure 1.1. The site is bordered on the south by the East Fork of Mill Creek, on the north by wooded, inactive land, on the east by Consolidated Railroad Corporation (Conrail) right-of-way, and on the west by Skinner Creek.

The site is located in a highly dissected area that slopes from a till-mantled bedrock upland to a broad, flat-bottomed valley that is occupied by the main branch of Mill Creek. Elevations on the site range from a high of nearly 800 feet above mean sea level (MSL) in the northeast to a low of 645 feet near the confluence of Skinner Creek and the East Fork of Mill Creek. Both Skinner Creek and the East Fork of Mill Creek are small, shallow streams. Both of these streams flow to the southwest from the site toward the main branch of Mill Creek. A third on-site stream, Dump Creek, borders the former landfill on the east; this creek is intermittent and flows south into the East Fork of Mill Creek. Three shallow ponds are also located on the site.

Though the Skinner property is comprised of approximately 78-acres of hilly terrain, only a portion of the site is subject to remedial action. As per the Statement of Work, the remedial action area is generally limited to a fenced area established under the December 9, 1992 Unilateral Administrative Order (UAO) relating to the first operable unit for the site. Throughout this report the remedial action work will refer to this fenced portion of the site.

1.3 Site History and Background

The property was originally developed as a sand and gravel mining operation, and was subsequently used as a landfill from 1934 to 1990. According to U.S. EPA, materials deposited at the site include demolition debris, household refuse and a wide variety of chemical wastes. The waste disposal areas include a now-buried waste lagoon near the center of the site and a landfill. According to U.S. EPA studies, the buried lagoon was used for the disposal of paint wastes, ink wastes, creosote, pesticides, and other chemical wastes. The landfill area, located north and northeast of the buried lagoon, received predominantly demolition and landscaping debris.

In 1976, the Ohio EPA (OEPA) initiated an investigation of the site in response to reports of a black oily liquid that was observed during a fire call to the site. Before the OEPA could complete the investigation, the landfill owners, the Skinners, covered the lagoon with a layer of solid waste and other debris. Mr. Skinner further dissuaded the OEPA from accessing the site by claiming that nerve gas, mustard gas and explosives were buried in the landfill. The OEPA requested the assistance of the U.S. Army after obtaining this information. Mr. Skinner later retracted his statements concerning buried ordnance, and a records review performed by the Army in 1992 revealed no evidence of munitions disposal at the site.

In 1982 the site was placed on the National Priority List by the U.S. EPA based on information obtained during a limited investigation of the site. The investigation indicated groundwater contamination had occurred as a result of the buried wastes. In 1986 a Phase I Remedial Investigation (RI) was conducted that included sampling of groundwater, surface water, and soil as well as a biological survey of the East Fork of Mill Creek and Skinner Creek. A Phase II RI was conducted from 1989 to 1991 and involved further investigation of groundwater, surface water, soils and sediments. A Baseline Risk Assessment and Feasibility Study were completed in 1992. The Record of Decision (ROD) was signed on June 4, 1993.

The field investigations have revealed that the most contaminated media at the site is the soil from the buried waste lagoon. Lower levels of contamination were also found in soils on other portions of the site and in the groundwater, and very low levels were found in the sediments of East Fork of Mill Creek, Skinner Creek, and the Duck and Diving Ponds. Migration of the landfill constituents has been limited, and the Phase II RI concluded that there had been no off-site migration of landfill constituents via groundwater.

1.4 Remedial Design Report Organization

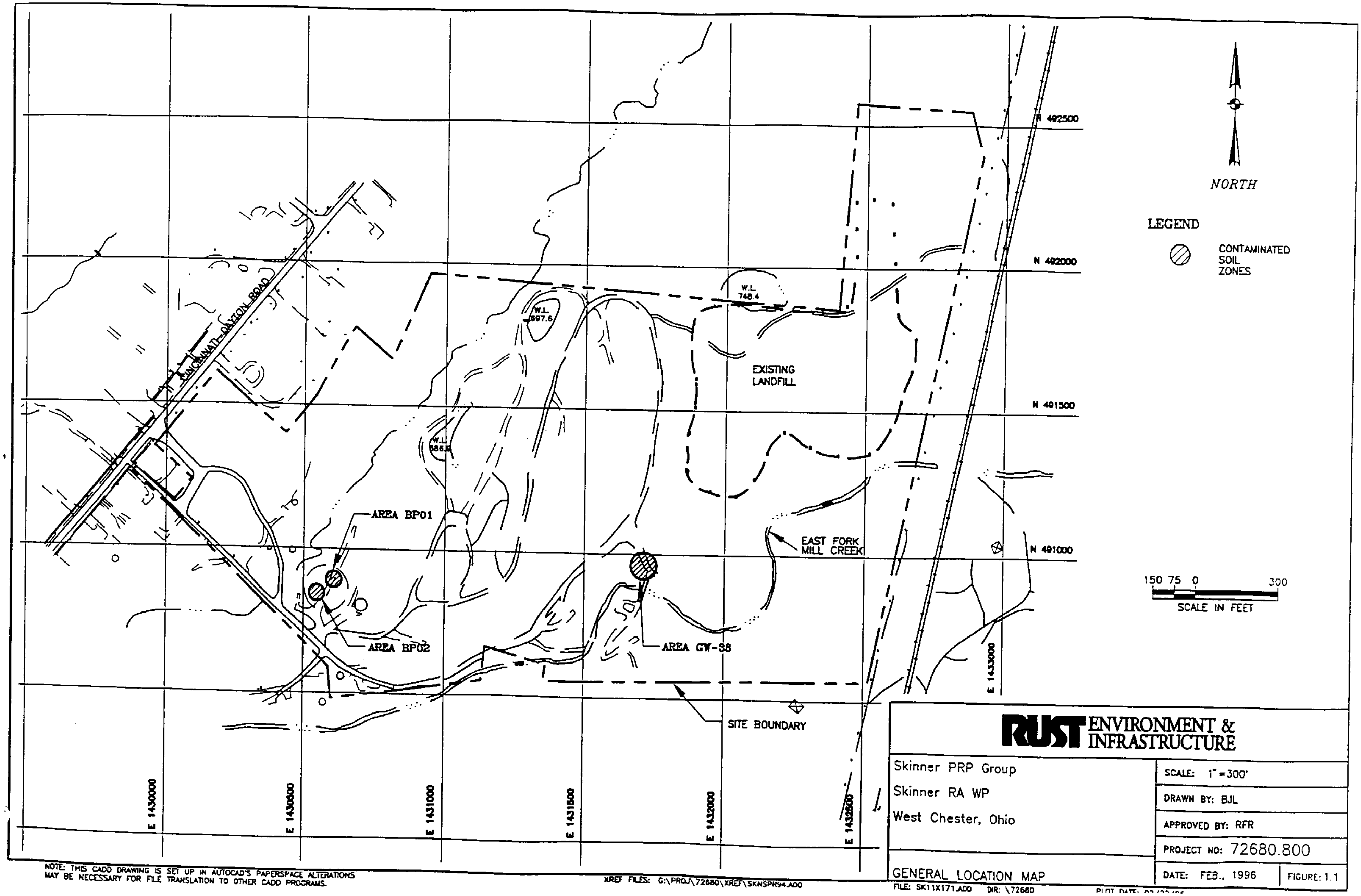
There are three primary elements to the design: groundwater interception, groundwater treatment, and landfill cover. Because each of these functions is considered a unique operation, the report is broken into separate sections. Each section is considered a self-contained unit, with separate design discussion, element description, installation and operation methodologies, drawings, and supporting documentation. This is done to allow separate preparation of bid and contract documents for each of these units. Section 2.0 provides the groundwater interception system design, Section 3.0 the groundwater treatment design, and Section 4.0 the landfill cover design.

To support these design elements, the SOW specified certain additional documents be included in the RD. Section 5.0 describes the overall contracting strategy to be used for implementation of the RA. Section 6.0 is a Remedial Action Work Plan that brings together all the design elements into a cohesive site implementation plan. Section 7.0 provides a cost estimate for Remedial Action. Section 8.0 consists of the revised Site Management Plans that were first developed as part of the Work Plan for Remedial Design. These documents include the QAPjP, FSP, HASP, and SPCC, AMP, Contingency Plan, and LTPP. Section 9.0 provides discussion of the Long Term Site management operations that will be conducted during the RA and after the remedial measures are in place. Finally, Section 10.0 provides information on the operation of the facilities.

In case of conflict between the specifications, drawings and text of this Remedial Design Report, the hierarchy of control shall be as follows:

1. Specifications.
2. Drawings.
3. Text of this report.

Figures



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2.0

2.0 GROUNDWATER INTERCEPTION SYSTEM DESIGN

This section describes the components of the groundwater interception system design. For clarity, "cut-off wall" refers to the low permeability barrier that will be installed to impede the flow of groundwater. "Interceptor trench" refers to a high permeability zone that will be installed to collect the groundwater. The term "trench" by itself refers to the cut-off wall, interceptor trench, or a combination thereof.

2.1 Summary of Preliminary Investigations and Data

The Groundwater Design Investigation (GWDI) activities had four major objectives with respect to groundwater interception:

- to confirm the stratigraphy along the proposed trench alignments;
- to determine the most feasible alignment for the trench;
- to determine the type of trench that is applicable to the remedial action, and;
- to determine the anticipated (estimated) flow from the interceptor trench.

The GWDI found that the stratigraphy consists of fill and/or glacial till at the surface, with layers or lenses of sand/gravel interspersed beneath the upper layer of till, and a second layer of glacial till which is situated above the bedrock. Along the trench alignment the depth to bedrock ranges from 10 to 40 feet (Drawing 2.3).

Several alternatives were evaluated in the GWDI. Among the alternatives were trench alignment, type of trench, and methods of groundwater interception and collection. The trench methods recommended were a combination of an interceptor trench and a cut-off wall. The cut-off wall was recommended in areas of relatively low groundwater flow, and the interceptor trench in those areas where higher groundwater flow was expected. Due to the variability of the stratigraphy, it was recommended that both trench types be installed using the slurry wall method of construction.

The flow rate from the trench is expected to vary with time. The initial drawdown of water within the interceptor trench will create relatively high gradients that will produce inflow estimated at 11,000 gpd (as defined in the GWDI). As the zone of influence of the trench expands (reducing gradients) and the water in "storage" above the eventual steady-state groundwater surface is depleted, the flow rate will decline. The estimated inflow rate at steady state is 454 gpd.

2.2 ARAR's and Permit Requirements

The following section is a brief discussion of the Federal and State Applicable or Relevant and Appropriate Requirements (ARAR's) for the Skinner Landfill Remedial Design/Action, as it relates to the groundwater interception system.

2.2.1 Federal ARAR's

Federal ARAR's for the Skinner Landfill are found as Table 3 in the Record of Decision (ROD). Under Federal ARAR's, the only requirement applicable to the trench design is to comply with the substantive requirements of a NPDES permit for stormwater discharge. Methods to achieve compliance with this ARAR are described below in Section 2.2.2.

2.2.2 State ARAR's

State ARAR's are found as Attachment 3 to the Statement of Work. Implementation of the trench system is subject to and meets several of these ARAR's.

Ohio Administrative Code (OAC) 3745-1-05, A, B and C is the OEPA policy for antidegradation of surface water. Additionally, 40 CFR Parts 122, 123, 124 and Section 402(p) of the CWA require substantive compliance with the requirements of the NPDES permit for stormwater discharge.

With respect to impacting the waters of the state, the trench will be installed to cut-off and collect groundwater before it can reach the East Fork of Mill Creek or migrate off-site. The trench is designed to intercept potentially contaminated groundwater from the area of the landfill and buried lagoon. During the construction process, diversion berm(s) will be utilized to prevent surface water and trench construction materials from flowing into the East Fork of Mill Creek from the area where the trench is being constructed. Additionally, other appropriate erosion and sedimentation control measures, such as silt fences and straw bales, will be utilized during the construction process. It is not anticipated at this time that there will be any point source discharge locations from the trench construction area. The erosion and sedimentation control effort will be monitored through the surface water monitoring activities.

OAC 3745-54-92 through 99 describe the groundwater protection standard, point of compliance, compliance period, and monitoring requirements, all of which are indirectly relevant to the trench system in that the trench is designed to achieve these criteria. To address these regulations, a long-term performance plan has been prepared and will be implemented for the area downgradient of the trench as part of the remedial action.

OAC 3745-55-14 requires all equipment that will be utilized on site to be decontaminated before leaving the site. Thus, the potential for off-site impact will be eliminated. A decontamination station is being incorporated into the design effort. All vehicles that come in contact with contaminated soils or waste will be required to be processed through the station prior to leaving the site.

2.3 Design Approach and Requirements

The objective of the trench design, in accordance with the SOW, is to prevent the discharge of contaminated groundwater from the landfill and buried lagoon area into the East Fork of Mill Creek.

The intercepted groundwater will be removed and pumped to the Butler County Department of Environmental Services (BCDES) sanitary sewer at the western end of the trench. This section will focus on the design of the cut-off wall, the interceptor trench, the groundwater removal system and the force main to its connection with the sanitary sewer line.

2.3.1 Concept

The hydraulic conductivity of the soils along the trench alignment varies considerably. In recognition of this variability, the predesign investigation report recommended the use of two types of trenches, a cut-off wall and an interceptor trench. The trenches are used singularly or in combination, as discussed in the GWDI, depending on the hydraulic conductivity of the soil and the relationship between the elevation of the creek bed and the bedrock elevation along the trench alignment.

The cut-off wall will be used in areas that have low hydraulic conductivity. Additionally the cut-off wall will be used in combination with the interceptor trench in areas where there is high hydraulic conductivity and the potential exists for the interceptor trench to draw water from the creek. The interceptor trench alone will be utilized in areas of high hydraulic conductivity, or in areas where the bedrock elevation along the trench alignment is above the creek elevation.

By utilizing the trenches and walls singularly or in combination, groundwater movement from the landfill will be intercepted prior to reaching the East Fork of Mill Creek. The cut-off wall will serve as a dam to prevent flow of water to or from the creek, and also prevent groundwater from flowing under the creek. The interceptor trench will serve to collect the groundwater flow. Once in the interceptor trenches, groundwater will be directed to sumps (within the trench) from which the water will be removed and conveyed to the sanitary sewer.

2.3.2 Plan

The trenches will be installed along a line approximately parallel to the creek as shown in Drawing 2.6. The trench will initiate at a point forty feet inside of the fence on the east end and follow the creek alignment westward for the majority of the trench length. As the trench system passes the knob where the lagoon is located, it will begin to more closely follow the base of the hill and move further away from the creek (to the north).

The cut-off wall, which extends from station 3+75 for approximately 975 feet to the west end of the trench (see Drawing 2.6), will be utilized in areas where the soil cross section has demonstrated a low permeability; that is, where the groundwater flow is expected to be relatively minimal. The cut-off wall will also be used in areas where the surface water elevation of the creek is above the interceptor trench bottom. The cut-off wall in these areas is intended to eliminate the potential for drawing water from the creek toward the trench alignment during water removal operations.

Additionally, it provides added protection against groundwater migrating under the creek and off-site, as the cut-off wall extends to the bedrock.

The interceptor trench will be used in areas where the soil cross section has demonstrated a high hydraulic conductivity; that is, where the groundwater flow is expected to have a moderate to high flow rate. The interceptor trench will allow flow from the soil cross section into the trench and will convey the flow to a sump for pumping/removal.

The trench design includes three stretches of interceptor trench. The first stretch extends from the east end of the trench approximately 375 feet to the west. The second stretch of interceptor trench extends from station 5+42 for approximately 160 feet to the west. The last stretch extends from approximately station 10+50 for approximately 295 feet to the west end of the trench.

The interceptor trench extends to the depths shown on the drawings in order to intercept the major sand/gravel seems. At the east end of the interception system the interceptor trench extends to the bedrock.

The pumping system for the removal of groundwater from the interceptor trench will be capable of pumping water, from a sump located in each of the three interceptor trenches, to the sanitary sewer line that runs along the East Fork of Mill Creek. Pumps are sized to have the capability of pumping groundwater to the discharge point when all three pumps are operating or when only one pump is operating. Calculations for the various cases are shown in Appendix 2-I.

Groundwater collection/transmission lines will run at varying depths beneath the ground surface (below frost depth, at a minimum of 30 inches) approximately parallel to existing contours. These lines will be located on the landfill side of the trench, approximately six (6) feet north of the trenches, so that any leakage from the lines will flow into the trench or be contained by the cut-off wall.

2.3.3 Basis

The anticipated flow rates along the trench as estimated in the GWDI report are shown in Table 2.1. It is anticipated that the zone of influence for the groundwater along the trench will be very narrow at the start up of the system. As the system operates, the zone of influence will extend. Information in the GWDI indicates that the zone of influence will ultimately extend up to 400 feet from the trench.

This estimate is based on a relatively continuous drawdown of the water in the trench. By relatively continuous, it is meant that the system will be operable at all times, but will be designed to operate within certain water levels in the trench. This will be done to avoid pump motor burnout and to provide cycle times for the pumps that fall within the manufacturer's recommendations. Additionally, this type of operation will allow for system operation under varying flow rates over the life of the project, by the adjustment of the level controls.

The purpose of installing cut-off walls in the low groundwater flow areas of the trench is to contain the groundwater and force it to flow toward the areas of higher hydraulic conductivity. Additionally, the cut-off wall will prevent draw-in of water from the adjacent creek. To accomplish this the cut-off wall will have a maximum hydraulic conductivity of 1×10^{-6} cm/sec and a minimum thickness of two (2) feet. This permeability represents at least an order of magnitude reduction in permeability compared to the lowest hydraulic conductivity calculated in the high flow cross sections. As compared to the sand/gravel seams in the stratigraphy, which are considered to be the major pathways for the groundwater flow, the cut-off wall(s) will have a hydraulic conductivity two to three orders of magnitude less than the sand/gravel seams. The cut-off walls will extend down to the bedrock, thus presenting a 1×10^{-6} cm/sec permeability "curtain" over the entire cross section height.

The interceptor trench will be installed in the areas of higher hydraulic conductivity. The interceptor trench will accept flow from the area upgradient of the trench, including flow from the sand/gravel seams that extend across the areas where cut-off walls are employed.

The interceptor trench consists of material that has a minimum hydraulic conductivity of 1×10^{-2} cm/sec. The trench will present a pathway for groundwater flow that is more permeable, by at least two orders of magnitude, than the sand/gravel seams that transport the flow to the trench area. The bottom of the collection trench will slope to a sump, where the groundwater will be removed and pumped to the discharge point. The trench will extend to a depth of approximately four feet below the sand/gravel seams (Drawing 2.3 and 2.5).

2.3.4 Performance Requirements

The purpose of the groundwater collection system is two fold; namely, to collect potentially contaminated groundwater for treatment, and to prevent the migration of contaminated groundwater from reaching or going beneath the East Fork of Mill Creek. A monitoring program as described in the Field Sampling Plan (FSP) has been developed that will measure groundwater quality between the trench and the creek. The effectiveness of the trench will be determined by comparing the long term groundwater quality south of the trench with the modified Table 1 Trigger Levels from the GWDI as described in the Long-Term Performance Plan (LTPP). It is stressed that the focus will be long term water quality as the construction activity will likely have a short-term impact on the groundwater flow in the area of the trench. Additionally, as there have been some "hits" along the trench alignment, it is anticipated that a minor amount of contamination will be found in the area at the time of the installation of the trench.

2.4 Design Elements Description

The following discussion outlines the key aspects of the groundwater collection and removal system. The scope of this section terminates at the discharge of the collected water into the sanitary sewer.

An earthen (clay) cap is identified on each trench to provide a surface for site traffic and to seal the trench and cut-off wall. The cap will extend beyond the trench on both sides. Earthen fill over the trenches will further protect against surface water in-flow to the trenches and protect the trenches. The force main is designed to withstand an over burden of approximately 9 feet (3' depth of pipe plus 6' of fill), at the deepest point, with a factor of safety of 1.5, to account for the maximum depth of the force main plus fill at the toe of slopes. Calculations indicate that the actual factor of safety is greater than 9.

The separation of the two trench types, where both trench types occur, will be approximately fifteen (15) feet on center. Both trenches will be constructed using slurry trench methods. The slurry is designed to be of a consistency to maintain the trench side walls such that there is minimal sloughing of the material adjacent to the trench. Additionally, once the collection trench is completed, the trench material approximates the strength of the material surrounding the trench. Thus, spacings less than the fifteen (15) feet on center spacing identified are possible. The fifteen (15) foot spacing was selected based on construction practices typically used, the space constraints at the site and acceptable practice within the industry.

2.4.1 Cut-Off Wall

The cut-off wall will consist of a low permeability layer approximately two feet thick. The wall will extend from two to three feet below the ground surface down to and keyed into the bedrock. The hydraulic conductivity of the wall will be less than or equal to 1×10^{-6} cm/sec. The wall will consist of a soil bentonite slurry that will solidify to provide the required permeability. The top of the wall will be capped with clay to provide a surface for site access and to protect the cut-off wall.

2.4.2 Interceptor Trench

The interceptor trench will be a vertical high permeability zone approximately two feet wide. It will intercept groundwater flow through all soils in its cross section, predominantly the sand/gravel seams. The interceptor trench will extend from 2 to 3 feet below the ground surface to approximately 4 to 5 feet below the lowest significant sand/gravel seams. Where the bedrock is shallow, as it is at the east end of the trench alignment, the trench extends to bedrock. In general the hydraulic conductivity of the trench will be greater than 1×10^{-2} cm/sec allowing for minimal deviations. The trench will be constructed of granular material with gradation to achieve or exceed the desired permeability. The granular material will be wrapped in a geotextile filter fabric to prevent fines from the surrounding soil and the sand/gravel seams from entering the material and lessening the permeability of the trench section (see Calculations in Appendix 2-I). The geotextile is installed such that there is sufficient overlap of the material to avoid gaps, and with sufficient tension such that folds are minimized.

The trench will be constructed utilizing the slurry trench method of construction. The slurry used will be a bio-polymer slurry. This bio-polymer slurry can be degraded by additives provided after the construction is complete. The residue left will not clog the trench and is non-hazardous in characterization. The extraction wells and the observation wells will be installed within the trench as construction of the trench progresses. No additional excavation will be required for the wells with the exception of excavation required to set the manholes and force main.

The geotextiles will be selected based on the Gradient Ratio (Clogging) Test. This test gives an indication of the gradient across a geotextile, based on the level of fines (<#200 sieve) in the adjacent soil. Some "clogging" of the geotextile is desired, as that is an indication that the geotextile is functioning to minimize the amount of fines that reach the drainage material. A gradient ratio of less than 3 will be identified in the remedial design specifications. A clay cap will be installed over the top of the granular section to prevent surface water from entering the trench.

The bottom of the interceptor trench will slope toward a low point of the trench to allow for groundwater removal at one point for each stretch of interceptor trench. The depth of the trench will vary, as shown on Drawing 2.6, in order to intercept the major sand/gravel seams and to accommodate a slope at the bottom of the trench. Some adjustment of the trench bottom will be required to accommodate conditions encountered (depth to bedrock, topography, etc.) in the field.

In the area from station 0+00 through approximately 3+80, an interceptor trench is identified. In this area, the primary sources of groundwater flow are the sand and gravel seams. These seams occur approximately five (5) to seven (7) feet above the base of the interceptor trench. The trench drainage material will have a permeability of 1×10^{-2} cm/sec. These two factors will cause the trench to be the predominant means of flow of the groundwater. Additionally, the pump will be designed to operate such as to minimize the level of water within the trench.

For the two interceptor trench sections that are in combination with the cut-off wall, the interceptor trench extends to a depth approximately four feet below significant sand/gravel seams. These two sections also have extraction wells at their low points. The extraction wells are located at the end of the interceptor trench closest to the west end of the trench.

2.4.3 Pumping System

Groundwater extraction points (wells) will be installed at the sump location of each interceptor trench. The wells will have down hole, submersible pumps rated at 25 gpm at 55 feet TDH (calculations are shown in Appendix 2-I). The pump discharge will be a 2" discharge line. The discharge line will extend to a point +/-3 feet below grade and tie into the force main at that elevation to prevent possible freeze-up. A manhole will be set at this location to facilitate access for control valves and to access the extraction well. The manholes are relatively remote and will be used for access to the extraction wells and associated equipment. As such, handholds will be provided in order to facilitate access and eliminate the need to carry step ladders to the manhole locations. The pumps will be cycled to maintain the water level in the trench within a predetermined range as shown on the Drawings. The pumps will be sized as previously discussed to pump the groundwater to the treatment location. The pumps may operate individually or in any combination.

2.4.4 Piping System

The piping system from the groundwater extraction wells to the treatment system will be installed on the north side of the interceptor trench. The line will be run approximately 30 inches deep to provide protection against frost. The force main will be constructed of 2 inch diameter High Density Polyethylene (HDPE). Pump timers will be installed to record the accumulated run time for each pump. The run times for the pumps will be recorded at the time of O&M visits. These pump times will then be converted into flows, based on the capacity of the pumps. Calculated flows will be periodically compared to measured flows (per the O&M Manual) to verify that the system is intact. Variations in these flows will be dealt with in accordance with the O&M Manual.

The sanitary sewer connection will be located near the west end of the trench. The manhole to be used to access the sanitary sewer is south of the trench, or outside the containment of the trench. Therefore, the pipe must "cross" the trench to reach the sewer. Where the piping runs from the north side of the trench to the sanitary sewer, it will be run approximately perpendicular to the trench. The force main will be encased in a containment pipe for all runs south of the trench. The containment pipe will slope to an inspection manhole that will have a level indicator. The indicator will trigger an alarm when the liquid level reaches a predetermined point. The manhole is designed in conformance with the Ten States Standards used by BCDES.

The piping system and the pumps are designed to handle a maximum daily flow of approximately 25,000 gallons per day or an instantaneous flow of 25 gpm per pump or 75 gpm (with all three pumps operating) total. This affords a factor of safety of 2.0 over the maximum anticipated flow rate identified in the GWDI report. The piping/pump system is designed to maintain a minimum velocity of 2.5 feet per second during operation.

2.4.5 Instrumentation and Control

The pumps will be controlled by means of high and low liquid level indicators. The pump will turn on when the liquid in the trench/extraction well reaches the high level indicator. Pumping will continue until the liquid level reaches the low level float. As an alarm condition, a high level detection device will be positioned above the high level float. If the liquid level in the trench reaches this point, a signal will be transmitted to the control panel identifying an alarm condition. The signal will be processed and a call initiated to a pre-established phone number with a recorded message identifying the location of the problem, such as: "high level at pump number 1". In addition to the locational message, the date and time will be recorded.

For the extraction wells, the control panels will be contained in the manhole enclosure at the top of the well. A central control panel will be located in the vicinity of the west end of the trench.

2.4.6 Layout

The general alignment of the trench is from east to west along the East Fork of Mill Creek. The trench runs along the creek approximately 20 feet to the north of the northern creek bank. This distance will allow for construction activities and vehicular access between the creek and the trench after construction is complete. Toward the west end of the trench the distance from the creek increases, as the trench follows the toe of the slope. The overall length of the trench is approximately 1355 feet.

The east end of the trench consists of an interceptor trench. The remainder of the trench has a cut-off wall, with two stretches of interceptor trench in conjunction with the cut-off wall along the alignment.

In the area where the East Fork of Mill Creek makes a sharp bend, there has been some bank erosion. The erosion of the bank in the area of GW-54 (approximately between stations 5+00 and 7+00) has slowed as it has progressed to the till layer. The horizontal distance from the stream bed to the trench is approximately 23 feet. Based on this information, the trench as designed will not be in immediate danger from erosion. However, there is a possibility that a monitoring well will be required in the vicinity. Therefore, the bank will be stabilized as indicated on the drawings.

2.4.7 Specifications

The specifications are included in Volume III of this submittal.

2.5 Constructability Evaluation

Based on past experience, knowledge of the site conditions and conversations with contractors; the following methods and sequencing of construction are proposed.

2.5.1 Methods

Based on the soil properties and the variable stratigraphy for the site, it is proposed that the trenches be constructed using the slurry trench method of construction.

2.5.2 Sequencing

It is recommended that the sequencing of the major activities of the trench construction be as follows:

- the collection trenches,
- the cut-off wall, and
- the force main.

This sequencing is based on the potential that when the cut-off wall is constructed, groundwater elevations behind the wall will rise. The higher groundwater may cause potential problems for the construction of the collection trench. The force main is sufficiently shallow that the groundwater should not be a problem. Note that the force main "crossing" will be installed at the time of the trench installation.

2.5.3 CQA

A Draft Construction Quality Assurance Plan (CQAP) is included in Volume IV of this submittal.

2.5.4 Stormwater Management

A diversion berm will be constructed prior to construction in order to contain slurry materials. Additionally, an erosion and sedimentation control plan has been prepared to minimize the impact on the East Fork of Mill Creek. Section 4.5.3 of this design report and Drawing 4.3 give a further description of the erosion and sedimentation controls.

2.5.5 Schedule

A milestone construction schedule is attached as Figure 5.1.

2.5.6 Cost Estimate

A Capital and O&M Cost Estimate is included in Section 7.0 of this submittal.

Tables

01/28/95

10:34 AM

Table 2.1

Skinner Landfill - Groundwater Remedial Design Investigation
Groundwater Flow into Trench

Station	Unit length of Trench X (ft)	GW Well Zone	Hydraulic Conductivity K (gpd/sf)	Influenced Thickness H (ft)	Iteration #1 Initial: Length of Influence L (ft)	Iteration #1 Initial: Collected Flow Q (gpm)	Iteration #2 Mid-term: L (ft)	Iteration #2 Mid-term: Q (gpm)	Iteration #3 Long term: L (ft)	Iteration #3 Long term: Q (gpm)	Iteration #4 Long term: L (ft)	Iteration #4 Long term: Q (gpm)
0+50	100	GW50	0.31	10	5	0.22	15	0.07	25	0.04	100	0.01
1+50	100	GW50	0.31	22	5	1.04	15	0.35	25	0.21	100	0.05
2+50	100	GW52*	0.31	16	5	0.55	15	0.18	25	0.11	100	0.03
3+50	50	GW52	0.03	21	5	0.05	15	0.02	25	0.01	100	0.00
4+50	No Collection Trench from Station 3+00 to Station 6+50											
5+50	Add 50 ft. on either side to be conservative											
6+50	100	GW53	1.19	10	5	0.83	15	0.28	25	0.17	100	0.04
7+50	100	GW54*	1.19	15	5	1.86	15	0.62	25	0.37	100	0.09
8+50	100	GW54*	1.19	10	5	0.83	15	0.28	25	0.17	100	0.04
9+50	100	GW54*	1.19	7	5	0.40	15	0.13	25	0.08	100	0.02
10+50^	100	GW56*	1.19	5	5	0.41	15	0.14	25	0.08	100	0.02
11+50^	100	GW56	3.43	2	5	0.19	15	0.06	25	0.04	100	0.01
12+50^	100	GW57*	3.43	5	5	1.19	15	0.40	25	0.24	100	0.06
13+50^	100	GW57	1.19	4	5	0.26	15	0.09	25	0.05	100	0.01
					Total (gpm)	7.8	gpm	2.6	gpm	1.6	gpm	0.4
					Total (gpd)	11,276	gpd	3,759	gpd	2,255	gpd	564

Flow Projection by Monitoring Well Zone (gpd)				
GW50	1,810	603	362	91
GW52	860	287	172	43
GW53	1,190	397	238	60
GW54	4,451	1,484	890	223
GW56	860	290	174	43
GW57	2,09[illegible]	699	419	105

Notes:

Values K, & H selected per 100 ft stationing using closest well K value and measured H

* Flow calculations used higher value from adjacent well for more conservative approach

^ Trench flow is from two(both) sides, therefore flow quantity was doubled

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE ____ OF ____

PROJECT NO. ____

CLIENT ____ SUBJECT ____ Prepared By ____ Date ____

PROJECT ____ ____ Reviewed By ____ Date ____

____ ____ Approved By ____ Date ____

I Pump Force Main

Calcs

Hydraulic Headlc alculation Form

1 of 10

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.04	
Location:	West Chester, OH	Pipe:	HDPE	**Iteration #1**
Project	Groundwater Extraction System	Assumed C value	150	**EW-1 Pump Only**
Project No.	72680.700	Size	2	
		C/K Source:	Crane, Cameron	

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	30	2	11.5	1.8236			0.2097
T-Branch Flow	2	695.5	1.14	30	2			3.0640	0.1458	0.1662
Shutoff Valve	3		0.33	30	2			3.0640	0.1458	0.0487
Piping	4		150	30	2	3	1.8236			0.0547
Regular 90 elbow	6		0.57	30	2			3.0640	0.1458	0.0831
piping	7		150	30	2	2	1.8236			0.0365
Regular 90 elbow	8		0.57	30	2			3.0640	0.1458	0.0831
Piping	9		150	30	2	2	1.8236			0.0365
Check Valve	10		1.90	30	2			3.0640	0.1458	0.2770
Regular 45	11		0.30	30	2			3.0640	0.1458	0.0437
Piping, EW-1 to EW-2	12		150.00	30	2	325.0000	1.8236			5.9268
Wye	13		0.24	30	2			3.0640	0.1458	0.0350
Piping, EW-1 to V/A-1	14		150	30	2	210	1.8236			3.8296
Butterfly Valve	15		0.86	30	2			3.0640	0.1458	0.1254
T-Line flow (iso valve)	16		0.38	30	2			3.0640	0.1458	0.0554
Piping, V/A-1 to MH-1	17		150	30	2	355	1.8236			6.4738
Butterfly Valve	18		0.86	30	2			3.0640	0.1458	0.1254
Wye	19		0.24	30	2			3.0640	0.1458	0.0350
Piping, MH-1 to VV	20		150	30	2	44	1.8236			0.8024
Butterfly valve	21		0.86	30	2			3.0640	0.1458	0.1254
flowmeter	22		0.1	30	2			3.0640	0.1458	0.0146
piping	23		150	30	2	5	1.8236			0.0912
Butterfly valve	24		0.86	30	2			3.0640	0.1458	0.1254
Piping, VV to GMH	25		150	30	2	70	1.8236			1.2765
Gavity flow Manhole	26		1	30	2			3.0640	0.1458	0.1458

Total Head Loss, ft 20.2267

HEADLS1.WK4,05/17/96

Prepared by Rcc Date 5/17/96

Checked by D.— Date 5/17/96

Hydraulic Headloss Calculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.04		
Location:	West Chester, OH	Pipe:	HDPE	**Iteration #2**	
Project	Groundwater Extraction System	Assumed C value	150	**EW-1, EW-2**	
Project No.	72680.700	Size	2	**Pumping**	
		C/K Source:	Crane, Cameron		

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	30	2	11.5	1.8236			0.2097
T-Branch Flow	2	695.5	1.14	30	2			3.0640	0.1458	0.1662
Shutoff Valve	3		0.33	30	2			3.0640	0.1458	0.0487
Piping	4		150	30	2	3	1.8236			0.0547
Regular 90 elbow	6		0.57	30	2			3.0640	0.1458	0.0831
piping	7		150	30	2	2	1.8236			0.0365
Regular 90 elbow	8		0.57	30	2			3.0640	0.1458	0.0831
Piping	9		150	30	2	2	1.8236			0.0365
Check Valve	10		1.90	30	2			3.0640	0.1458	0.2770
Regular 45	11		0.30	30	2			3.0640	0.1458	0.0437
Piping, EW-1 to EW-2	12		150.00	30	2	325.0000	1.8236			5.9268
Wye	13		0.24	30	2			3.0640	0.1458	0.0350
Piping, EW-1 to V/A-1	14		150	60	2	210	6.5741			13.8057
Butterfly Valve	15		0.86	60	2			6.1281	0.5831	0.5015
T-Line flow (iso valve)	16		0.38	60	2			6.1281	0.5831	0.2216
Piping, V/A-1 to MH-1	17		150	60	2	355	6.5741			23.3382
Butterfly Valve	18		0.86	60	2			6.1281	0.5831	0.5015
Wye	19		0.24	60	2			6.1281	0.5831	0.1400
Piping, MH-1 to VV	20		150	60	2	44	6.5741			2.8926
Butterfly valve	21		0.86	60	2			6.1281	0.5831	0.5015
flowmeter	22		0.1	60	2			6.1281	0.5831	0.0583
piping	23		150	60	2	5	6.5741			0.3287
Butterfly valve	24		0.86	60	2			6.1281	0.5831	0.5015
Piping, VV to GMH	25		150	60	2	70	6.5741			4.6019
Gavity flow Manhole	26		1	60	2			6.1281	0.5831	0.5831

Total Head Loss, ft 54.9769

Prepared by ECC Date 5/17/96 Checked by [illegible] Date 5/17/96

Hydraulic Headloss Calculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.04
Location:	West Chester, OH	Pipe:	HDPE
Project	Groundwater Extraction System	Assumed C value	150
Project No.	72680.700	Size	2
		C/K Source:	Crane, Cameron

Iteration #3
EW-1,EW-2,
EW-3 Pumps On

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	30	2	11.5	1.8236			0.2097
T-Branch Flow	2	695.5	1.14	30	2			3.0640	0.1458	0.1662
Shutoff Valve	3		0.33	30	2			3.0640	0.1458	0.0487
Piping	4		150	30	2	3	1.8236			0.0547
Regular 90 elbow	6		0.57	30	2			3.0640	0.1458	0.0831
piping	7		150	30	2	2	1.8236			0.0365
Regular 90 elbow	8		0.57	30	2			3.0640	0.1458	0.0831
Piping	9		150	30	2	2	1.8236			0.0365
Check Valve	10		1.90	30	2			3.0640	0.1458	0.2770
Regular 45	11		0.30	30	2			3.0640	0.1458	0.0437
Piping, EW-1 to EW-2	12		150.00	30	2	325.0000	1.8236			5.9268
Wye	13		0.24	30	2			3.0640	0.1458	0.0350
Piping, EW-1 to V/A-1	14		150	60	2	210	6.5741			13.8057
Butterfly Valve	15		0.86	60	2			6.1281	0.5831	0.5015
T-Line flow (iso valve)	16		0.38	60	2			6.1281	0.5831	0.2216
Piping, V/A-1 to MH-1	17		150	60	2	355	6.5741			23.3382
Butterfly Valve	18		0.86	60	2			6.1281	0.5831	0.5015
Wye	19		0.24	60	2			6.1281	0.5831	0.1400
Piping, MH-1 to VV	20		150	90	2	44	13.9190			6.1244
Butterfly valve	21		0.86	90	2			9.1921	1.3120	1.1283
flowmeter	22		0.1	90	2			9.1921	1.3120	0.1312
piping	23		150	90	2	5	13.9190			0.6959
Butterfly valve	24		0.86	90	2			9.1921	1.3120	1.1283
Piping, VV to GMH	25		150	90	2	70	13.9190			9.7433
Gavity flow Manhole	26		1	90	2			9.1921	1.3120	1.3120

Total Head Loss, ft 65.7728

HEADLS1.WK4,05/17/96

Prepared by RCC Date 5/17/96

Checked by DM Date 5/17/96

·ydraulic Headlo· ·lculation Form

47.0

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.04
Location:	West Chester, OH	Pipe:	HDPE
Project	Groundwater Extraction System	Assumed C value	150
Project No.	72680.700	Size	2
		C/K Source:	Crane, Cameron

Iteration #1
EW-1 Pump Only

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	25	2	11.5	1.3015			0.1497
T-Branch Flow	2	695.5	1.14	25	2			2.5534	0.1012	0.1154
Shutoff Valve	3		0.33	25	2			2.5534	0.1012	0.0338
Piping	4		150	25	2	3	1.3015			0.0390
Regular 90 elbow	6		0.57	25	2			2.5534	0.1012	0.0577
piping	7		150	25	2	2	1.3015			0.0260
Regular 90 elbow	8		0.57	25	2			2.5534	0.1012	0.0577
Piping	9		150	25	2	2	1.3015			0.0260
Check Valve	10		1.90	25	2			2.5534	0.1012	0.1924
Regular 45	11		0.30	25	2			2.5534	0.1012	0.0304
Piping, EW-1 to EW-2	12		150.00	25	2	325.0000	1.3015			4.2299
Wye	13		0.24	25	2			2.5534	0.1012	0.0243
Piping, EW-1 to V/A-1	14		150	25	2	210	1.3015			2.7332
Butterfly Valve	15		0.86	25	2			2.5534	0.1012	0.0871
T-Line flow (iso valve)	16		0.38	25	2			2.5534	0.1012	0.0385
Piping, V/A-1 to MH-1	17		150	25	2	355	1.3015			4.6204
Butterfly Valve	18		0.86	25	2			2.5534	0.1012	0.0871
Wye	19		0.24	25	2			2.5534	0.1012	0.0243
Piping, MH-1 to VV	20		150	25	2	44	1.3015			0.5727
Butterfly valve	21		0.86	25	2			2.5534	0.1012	0.0871
flowmeter	22		0.1	25	2			2.5534	0.1012	0.0101
piping	23		150	25	2	5	1.3015			0.0651
Butterfly valve	24		0.86	25	2			2.5534	0.1012	0.0871
Piping, VV to GMH	25		150	25	2	70	1.3015			0.9111
Gavity flow Manhole	26		1	25	2			2.5534	0.1012	0.1012

Total Head Loss, ft 14.4071

HEADLS1.WK4,05/17/96

Prepared by RCC Date 5/17/96

Checked by DM Date 5/17/96

5 p 10

Hydraulic Headloss Calculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.04	
Location:	West Chester, OH	Pipe:	HDPE	**Iteration #2**
Project	Groundwater Extraction System	Assumed C value	150	**EW-1, EW-2**
Project No.	72680.700	Size	2	**Pumping**
		C/K Source:	Crane, Cameron	

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	25	2	11.5	1.3015			0.1497
T-Branch Flow	2	695.5	1.14	25	2			2.5534	0.1012	0.1154
Shutoff Valve	3		0.33	25	2			2.5534	0.1012	0.0338
Piping	4		150	25	2	3	1.3015			0.0390
Regular 90 elbow	6		0.57	25	2			2.5534	0.1012	0.0577
piping	7		150	25	2	2	1.3015			0.0260
Regular 90 elbow	8		0.57	25	2			2.5534	0.1012	0.0577
Piping	9		150	25	2	2	1.3015			0.0260
Check Valve	10		1.90	25	2			2.5534	0.1012	0.1924
Regular 45	11		0.30	25	2			2.5534	0.1012	0.0304
Piping, EW-1 to EW-2	12		150.00	25	2	325.0000	1.3015			4.2299
Wye	13		0.24	25	2			2.5534	0.1012	0.0243
Piping, EW-1 to V/A-1	14		150	50	2	210	4.6920			9.8531
Butterfly Valve	15		0.86	50	2			5.1067	0.4049	0.3483
T-Line flow (iso valve)	16		0.38	50	2			5.1067	0.4049	0.1539
Piping, V/A-1 to MH-1	17		150	50	2	355	4.6920			16.6564
Butterfly Valve	18		0.86	50	2			5.1067	0.4049	0.3483
Wye	19		0.24	50	2			5.1067	0.4049	0.0972
Piping, MH-1 to VV	20		150	50	2	44	4.6920			2.0645
Butterfly valve	21		0.86	50	2			5.1067	0.4049	0.3483
flowmeter	22		0.1	50	2			5.1067	0.4049	0.0405
piping	23		150	50	2	5	4.6920			0.2346
Butterfly valve	24		0.86	50	2			5.1067	0.4049	0.3483
Piping, VV to GMH	25		150	50	2	70	4.6920			3.2844
Gavity flow Manhole	26		1	50	2			5.1067	0.4049	0.4049

Total Head Loss, ft 39.1648

HEADLS1.WK4,05/17/96

Prepared by RCC Date 5/17/96

Checked by DM Date 5/17/96

6 . 10

Hydraulic Headloss Calculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.04	
Location:	West Chester, OH	Pipe:	HDPE	**Iteration #3**
Project	Groundwater Extraction System	Assumed C value	150	**EW-1,EW-2,**
Project No.	72680.700	Size	2	**EW-3 Pumps On**
		C/K Source:	Crane, Cameron	

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	25	2	11.5	1.3015			0.1497
T-Branch Flow	2	695.5	1.14	25	2			2.5534	0.1012	0.1154
Shutoff Valve	3		0.33	25	2			2.5534	0.1012	0.0338
Piping	4		150	25	2	3	1.3015			0.0390
Regular 90 elbow	6		0.57	25	2			2.5534	0.1012	0.0577
piping	7		150	25	2	2	1.3015			0.0260
Regular 90 elbow	8		0.57	25	2			2.5534	0.1012	0.0577
Piping	9		150	25	2	2	1.3015			0.0260
Check Valve	10		1.90	25	2			2.5534	0.1012	0.1924
Regular 45	11		0.30	25	2			2.5534	0.1012	0.0304
Piping, EW-1 to EW-2	12		150.00	25	2	325.0000	1.3015			4.2299
Wye	13		0.24	25	2			2.5534	0.1012	0.0243
Piping, EW-1 to V/A-1	14		150	50	2	210	4.6920			9.8531
Butterfly Valve	15		0.86	50	2			5.1067	0.4049	0.3483
T-Line flow (iso valve)	16		0.38	50	2			5.1067	0.4049	0.1539
Piping, V/A-1 to MH-1	17		150	50	2	355	4.6920			16.6564
Butterfly Valve	18		0.86	50	2			5.1067	0.4049	0.3483
Wye	19		0.24	50	2			5.1067	0.4049	0.0972
Piping, MH-1 to VV	20		150	75	2	44	9.9340			4.3709
Butterfly valve	21		0.86	75	2			7.6601	0.9111	0.7836
flowmeter	22		0.1	75	2			7.6601	0.9111	0.0911
piping	23		150	75	2	5	9.9340			0.4967
Butterfly valve	24		0.86	75	2			7.6601	0.9111	0.7836
Piping, VV to GMH	25		150	75	2	70	9.9340			6.9538
Gavity flow Manhole	26		1	75	2			7.6601	0.9111	0.9111

Total Head Loss, ft 46.8303

HEADLS1.WK4,05/17/96

Prepared by KW Date 5/17/96 Checked by DM Date 5/17/96

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Hydraulic Headl. ʾalculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.03	
Location:	West Chester, OH	Pipe:	HDPE	**Iteration #1**
Project	Groundwater Extraction System	Assumed C value	150	**EW-1 Pump Only**
Project No.	72680.700	Size	2	
		C/K Source:	Crane, Cameron	

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	20	2	11.5	0.8613			0.0991
T-Branch Flow	2	695.5	1.14	20	2			2.0427	0.0648	0.0739
Shutoff Valve	3		0.33	20	2			2.0427	0.0648	0.0216
Piping	4		150	20	2	3	0.8613			0.0258
Regular 90 elbow	6		0.57	20	2			2.0427	0.0648	0.0369
piping	7		150	20	2	2	0.8613			0.0172
Regular 90 elbow	8		0.57	20	2			2.0427	0.0648	0.0369
Piping	9		150	20	2	2	0.8613			0.0172
Check Valve	10		1.90	20	2			2.0427	0.0648	0.1231
Regular 45	11		0.30	20	2			2.0427	0.0648	0.0194
Piping, EW-1 to EW-2	12		150.00	20	2	325.0000	0.8613			2.7993
Wye	13		0.24	20	2			2.0427	0.0648	0.0156
Piping, EW-1 to V/A-1	14		150	20	2	210	0.8613			1.8088
Butterfly Valve	15		0.86	20	2			2.0427	0.0648	0.0557
T-Line flow (iso valve)	16		0.38	20	2			2.0427	0.0648	0.0246
Piping, V/A-1 to MH-1	17		150	20	2	355	0.8613			3.0577
Butterfly Valve	18		0.86	20	2			2.0427	0.0648	0.0557
Wye	19		0.24	20	2			2.0427	0.0648	0.0156
Piping, MH-1 to VV	20		150	20	2	44	0.8613			0.3790
Butterfly valve	21		0.86	20	2			2.0427	0.0648	0.0557
flowmeter	22		0.1	20	2			2.0427	0.0648	0.0065
piping	23		150	20	2	5	0.8613			0.0431
Butterfly valve	24		0.86	20	2			2.0427	0.0648	0.0557
Piping, VV to GMH	25		150	20	2	70	0.8613			0.6029
Gavity flow Manhole	26		1	20	2			2.0427	0.0648	0.0648

Total Head Loss, ft 9.5118

HEADLS1.WK4,05/17/96

Prepared by Kcc Date 5/17/9

Checked by Dm Date 5/17/96

Hydraulic Headloss Calculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.03		
Location:	West Chester, OH	Pipe:	HDPE		Iteration #2
Project	Groundwater Extraction System	Assumed C value	150		EW-1, EW-2
Project No.	72680.700	Size	2		Pumping
		C/K Source:	Crane, Cameron		

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	20	2	11.5	0.8613			0.0991
T-Branch Flow	2	695.5	1.14	20	2			2.0427	0.0648	0.0739
Shutoff Valve	3		0.33	20	2			2.0427	0.0648	0.0216
Piping	4		150	20	2	3	0.8613			0.0258
Regular 90 elbow	6		0.57	20	2			2.0427	0.0648	0.0369
piping	7		150	20	2	2	0.8613			0.0172
Regular 90 elbow	8		0.57	20	2			2.0427	0.0648	0.0369
Piping	9		150	20	2	2	0.8613			0.0172
Check Valve	10		1.90	20	2			2.0427	0.0648	0.1231
Regular 45	11		0.30	20	2			2.0427	0.0648	0.0194
Piping, EW-1 to EW-2	12		150.00	20	2	325.0000	0.8613			2.7993
Wye	13		0.24	20	2			2.0427	0.0648	0.0156
Piping, EW-1 to V/A-1	14		150	40	2	210	3.1051			6.5206
Butterfly Valve	15		0.86	40	2			4.0854	0.2592	0.2229
T-Line flow (iso valve)	16		0.38	40	2			4.0854	0.2592	0.0985
Piping, V/A-1 to MH-1	17		150	40	2	355	3.1051			11.0230
Butterfly Valve	18		0.86	40	2			4.0854	0.2592	0.2229
Wye	19		0.24	40	2			4.0854	0.2592	0.0622
Piping, MH-1 to VV	20		150	40	2	44	3.1051			1.3662
Butterfly valve	21		0.86	40	2			4.0854	0.2592	0.2229
flowmeter	22		0.1	40	2			4.0854	0.2592	0.0259
piping	23		150	40	2	5	3.1051			0.1553
Butterfly valve	24		0.86	40	2			4.0854	0.2592	0.2229
Piping, VV to GMH	25		150	40	2	70	3.1051			2.1735
Gavity flow Manhole	26		1	40	2			4.0854	0.2592	0.2592

Total Head Loss, ft 25.8620

HEADLS1.WK4,05/17/96

Prepared by ECC Date 5/17/96

Checked by D.M. Date 5/17/96

Hydraulic Headloss Calculation Form

Client:	Skinner Landfill PRP Group	Design Flow Rate, M	0.03
Location:	West Chester, OH	Pipe:	HDPE
Project	Groundwater Extraction System	Assumed C value	150
Project No.	72680.700	Size	2
		C/K Source:	Crane, Cameron

Iteration #3
EW-1,EW-2,
EW-3 Pumps On

Item	Segment	Invert Elev ft	C or K Value	Flow, gpm	Inside Dia in	Length, ft	Hf/L ft/100ft	Vel ft/sec	V2/2g ft	H loss ft
Extraction Well riser	1	684	150	20	2	11.5	0.8613			0.0991
T-Branch Flow	2	695.5	1.14	20	2			2.0427	0.0648	0.0739
Shutoff Valve	3		0.33	20	2			2.0427	0.0648	0.0216
Piping	4		150	20	2	3	0.8613			0.0258
Regular 90 elbow	6		0.57	20	2			2.0427	0.0648	0.0369
piping	7		150	20	2	2	0.8613			0.0172
Regular 90 elbow	8		0.57	20	2			2.0427	0.0648	0.0369
Piping	9		150	20	2	2	0.8613			0.0172
Check Valve	10		1.90	20	2			2.0427	0.0648	0.1231
Regular 45	11		0.30	20	2			2.0427	0.0648	0.0194
Piping, EW-1 to EW-2	12		150.00	20	2	325.0000	0.8613			2.7993
Wye	13		0.24	20	2			2.0427	0.0648	0.0156
Piping, EW-1 to V/A-1	14		150	40	2	210	3.1051			6.5206
Butterfly Valve	15		0.86	40	2			4.0854	0.2592	0.2229
T-Line flow (iso valve)	16		0.38	40	2			4.0854	0.2592	0.0985
Piping, V/A-1 to MH-1	17		150	40	2	355	3.1051			11.0230
Butterfly Valve	18		0.86	40	2			4.0854	0.2592	0.2229
Wye	19		0.24	40	2			4.0854	0.2592	0.0622
Piping, MH-1 to VV	20		150	60	2	44	6.5741			2.8926
Butterfly valve	21		0.86	60	2			6.1281	0.5831	0.5015
flowmeter	22		0.1	60	2			6.1281	0.5831	0.0583
piping	23		150	60	2	5	6.5741			0.3287
Butterfly valve	24		0.86	60	2			6.1281	0.5831	0.5015
Piping, VV to GMH	25		150	60	2	70	6.5741			4.6019
Gavity flow Manhole	26		1	60	2			6.1281	0.5831	0.5831

Total Head Loss, ft 30.9038

HEADLS1.WK4,05/17/96

Prepared by RCC Date 5/17/96

Checked by D.M. Date 5/17/96

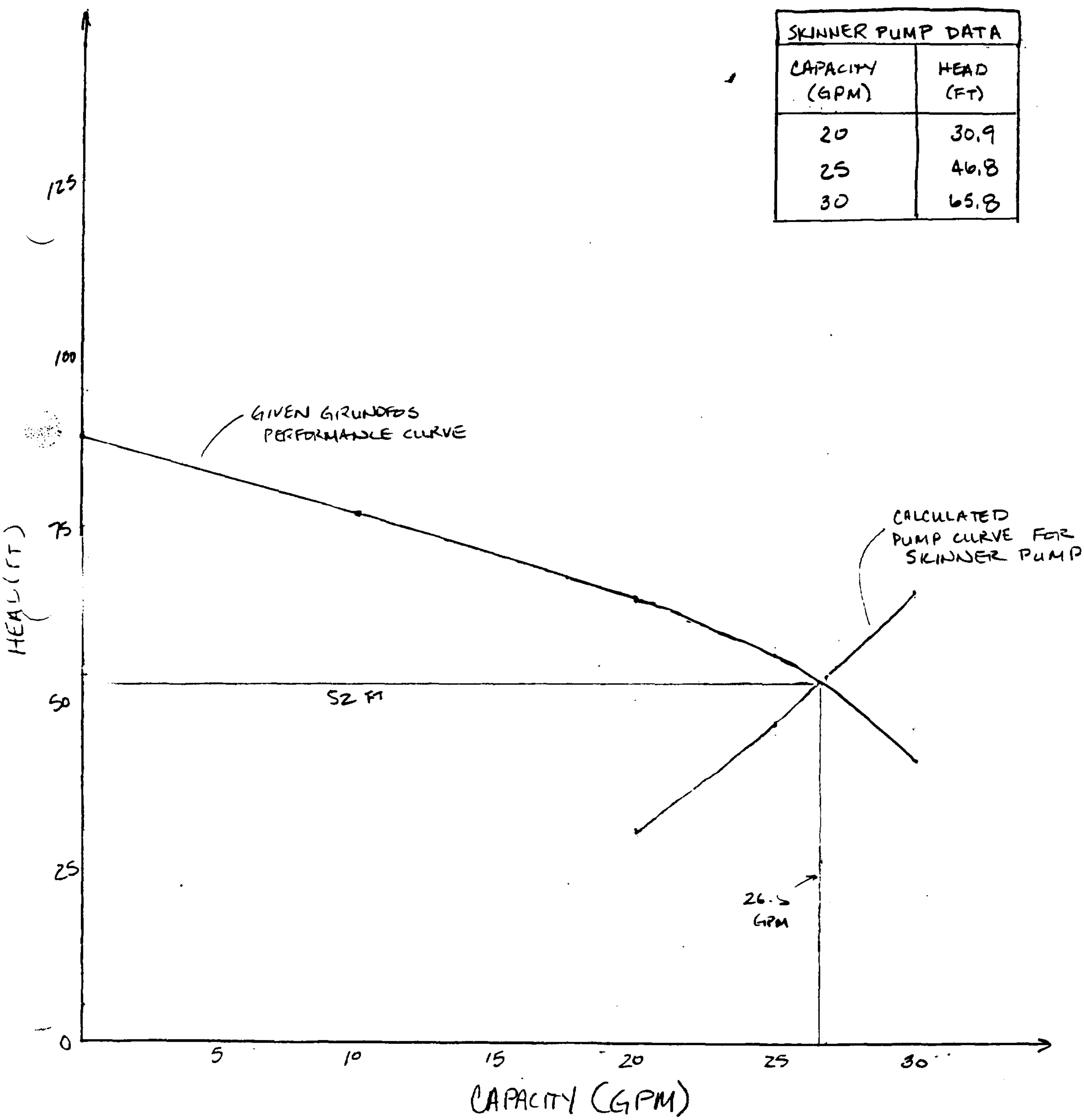
RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 72680.500

CLIENT SKINNER	SUBJECT OPERATING	Prepared By MME Date 5/17/96
PROJECT SKINNER	PARAMETERS FOR	Reviewed By RES Date 5-17-96
LANDFILL	SKINNER PUMP	Approved By ______ Date ______

SKINNER PUMP DATA	
CAPACITY (GPM)	HEAD (FT)
20	30.9
25	46.8
30	65.8



RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE ____ OF ____

PROJECT NO. ____

CLIENT ____ SUBJECT ____ Prepared By ____ Date ____

PROJECT ____ Reviewed By ____ Date ____

Approved By ____ Date ____

II TRENCH CAPACITY

ESTIMATE CALCS

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE ____ OF ____
PROJECT NO. ________

CLIENT Skinner PRP's
SUBJECT Collection Trench Storage Capacity
Prepared By DM Date 1/29/96
PROJECT Skinner L.F.
Reviewed By RCR Date 5/17/96
Approved By ______ Date ______

- Storage In Collection Trench

  The Storage In The East Most Collection Trench

  Basis: 2' Of Width
  5-7' Of Depth Below Granular Seams
  375' Of Trench Length
  50% Of Trench Is Granular ($e \approx 1.0$)

$$Vol = 2' \times 5' \times 375' \times (.50) = 1875 Ft^3$$
$$= 14062 Gal$$

Factor Of Safety / Days Storage Capacity

The Eastern Most Collection Trench Capacity

- This Trench Represents Approximately 46 % Of The Trench Wall Surface Area $\left\{ \frac{5200 Ft^2}{11180 Ft^2} \cdot 100 \right.$
- Surface Area Is An Indication Of The Percent Of Groundwater To Reach The Trench
- Ground Water Trench Yield Is Approx 11,000 GPD

Days Storage =

$$14062 Gal / (11000 GPD \cdot .46) \approx 2.8 Days$$

Assuming Some Level In The Trench (Say 0.80 Days Vol.) This Allows 2 Days To Respond Before There Is A Potential For By Passing Trench.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE ____ OF ____

PROJECT NO. ____

CLIENT ____ SUBJECT ____ Prepared By ____ Date ____

PROJECT ____ Reviewed By ____ Date ____

Approved By ____ Date ____

III GEOTEXTILE SELECTION

CALCS

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. ____

CLIENT ____

SUBJECT CUT-OFF TRENCH

Prepared By TJL Date 2/7

PROJECT SKINNER LANDFILL

Reviewed By JM Date 3/7/96

Approved By ____ Date ____

OBJECTIVE:

SIZE THE GEOTEXTILE TO MINIMIZE POSSIBLE CLOGGING AND MAXIMIZE FLOW RATE.

REFERENCES:

1.) KOERNER, "DESIGNING WITH GEOSYNTHETICS", THIRD ED., 1994.

2.) UNIV. OF WISCONSIN-MADISON, "SANITARY LANDFILL DESIGN", 1993, SECTION 3, JOE SPEAR, "DESIGNING AND IMPLEMENTING LANDFILL COVER SYSTEMS"

PROCEDURE

1.) FROM MANUFACTURER LITERATURE SELECT APPROPRIATE GEOTEXTILE

2.) CHECK OPENING SIZE VS. GEOTEXTILE CRITERIA

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. ______

CLIENT S

SUBJECT CUT-OFF TRENCH

PROJECT SKINNER LANDFILL

Prepared By TJC Date 3/7

Reviewed By TM Date 3/17/96

Approved By ______ Date ______

RESULTS

FROM REF 1 (Pg 3 of 5) IT IS SEEN THAT A WOVEN MONOFILAMENT GEOTEXTILE IS THE MOST LIKELY GEOTEXTILE TO RESIST CLOGGING.

EXAMINING THE SPECIFICATIONS FOR GEOSYNTHETIC INDUSTRIES WOVEN MONOFILAMENT GEOTEXTILES, (pages 4 and 5 of 5) SIE III WAS CHOSEN.

COMPARE OPENING SIZE (40 U.S. STD. SIEVE) WITH AVERAGE SOIL SIZE WITH THE FOLLOWING EQUATIONS

$$\frac{O_{95}\ \text{GEOTEX.}}{D_{85}\ \text{SOIL}} < 2 \qquad \text{AND} \qquad \frac{O_{95}\ \text{GEOTEX}}{D_{15}\ \text{SOIL}} > 2$$

WHERE O_{95} = APPARENT OPENING SIZE (AOS)

D_{85} = SIZE WITH 85% FINER PASSING

D_{15} = SIZE WITH 15% FINER PASSING

$$\frac{O_{95}}{D_{85}} = \frac{.425}{15.77} = .027 < 2 \qquad \frac{O_{95}}{D_{15}} = \frac{.425}{.0196} = 21.68 > 2$$

∴ THE SELECTED GEOTEXTILE MEETS THE FILTER REQUIREMENTS.

Pg 3 of 5

DM 3/17/98

Wood [6] assessed the Corps' test. Figure 2.22 gives their data illustrating various combinations of soil types and geotextiles. The soil types were systematically varied from an ideal rounded sand (Ottawa test sand) to controlled mixtures of sand and silt, by varying the percentage of silt added (i.e.. a gap-graded soil of increasing silt content was created). When different geotextile styles were evaluated with each soil type, the gradient ratio response was measured. The nonwovens and woven slit-film geotextiles failed (GR > 3.0) as higher percentages of silt were added, but in general the woven monofilament geotextiles behaved nicely (i.e., gradient ratio values remained low). This type of response is powerful in leading one toward the use of woven monofilament geotextiles for critical hydraulic applications. However, these are severe test conditions in which high hydraulic gradients, cohesionless soils, and gap-graded particle size distributions are present. These three conditions appear to lead to excessive soil clogging problems when using certain types of geotextiles. In this regard, it is important to note that Haliburton and Wood did not report on the amount of silt that passed through the high-open-area woven geotextiles that had such low gradient ratio values.

The test is not without its share of problems and complications, including long-term stability of the gradient ratio value [7], piping along the test cylinder walls, use of deaired or deionized water, and air pockets in the soil, geotextile, and tubing system.

2.3.5.8 Hydraulic Conductivity Ratio (Clogging) Test Williams and Abouzakhm [48] have suggested the use of a flexible wall permeameter test to assess not only excessive clogging conditions, but also excessive soil loss and equilibrium condi-

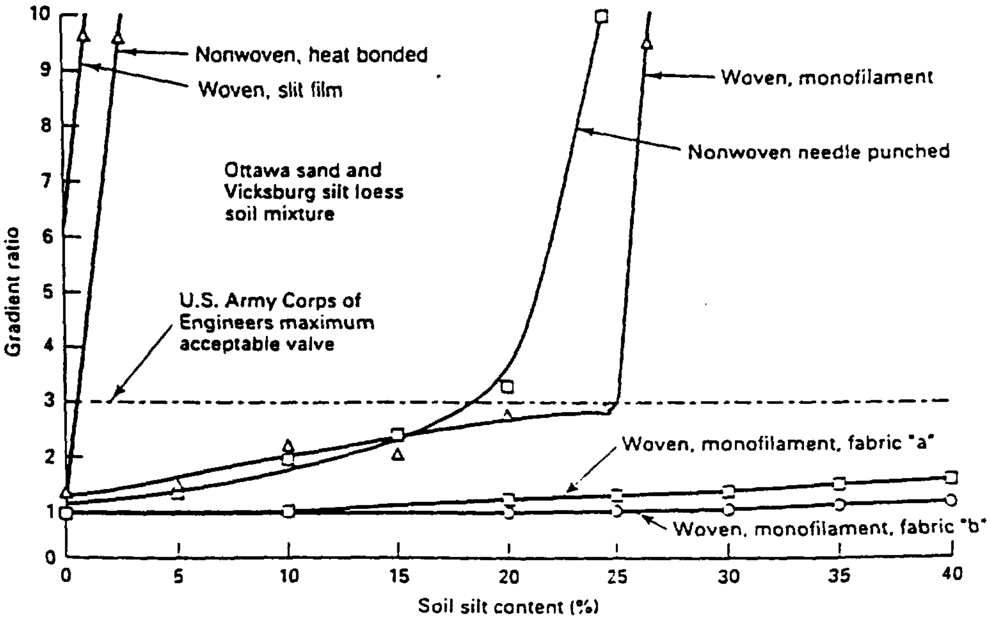


Figure 2.22 Gradient ratio test data used to illustrate geotextile clogging potential (after Haliburton and Wood [6]).

[RGF # 1]

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3/7/96

SYNTHETIC INDUSTRIES

Construction Products Division is your Task Force for Engineered Geosynthetic Products, ranging from innovative erosion control product technologies to strong construction fabrics for waste disposal facilities. This broad complement of high quality products is supported by the full resources of Synthetic Industries, which includes over 10 years of experience in the geosynthetics industry and a qualified and dedicated team of employees.

Our polypropylene geotextiles are manufactured by three processes to give the engineer three distinctly different technical products to help solve site specific problems. A Synthetic Industries woven monofilament geotextile is manufactured from extruded polypropylene monofilaments woven together to form a dimensionally stable construction fabric.
This type of geotextile is primarily used in:

- ▲ Erosion control applications
- ▲ Drainage applications

EROSION CONTROL

Soil migration from beneath inland waterway protection systems is the largest cause of slope erosion failures. Monofilament geotextiles prevent piping by retaining soil particles in place while still allowing high water flow through the fabric. Because these products feature open areas ranging from 5 to 20 percent, Synthetic Industries monofilaments have excellent clogging resistance.

Erosion I through V can be used in any inland waterway erosion control system. By varying the degree of calendering in the manufacturing process, Synthetic Industries has created a line of woven monofilaments that offer the designer fabrics with various hydraulic and filtration properties such as percent open area, apparent opening size, and water flow rate.

Erosion X features the highest percent open area (POA>15%) and water flow rate (200 gpm/ft²) of all the monofilaments. This geotextile has been engineered for systems constructed under high hydraulic gradients where clogging is the primary concern.

Erosion XV is a specialty monofilament (fibrillated fill yarn) manufactured for erosion control beneath hard armor systems (articulated blocks, large riprap stone, etc.) that are commonly used in high velocity channels and shorelines subjected to wave action. Its rugged construction makes it extremely resistant to construction loadings while still maintaining adequate water flow rates (40 gpm/ft²).

DRAINAGE

Synthetic Industries woven monofilament geotextiles Erosion I through Erosion X are excellent candidates as filters in drainage systems. These geotextiles are used around coarse gravel for leachate collection pipe systems in solid waste landfills. These monofilaments have less surface area for potential biological growth, which helps to eliminate clogging concerns.

Erosion I through V are also good filtration products to use in subsurface drainage systems. A high groundwater table present (i.e. constant drawdown) is an example that warrants the use of these styles of woven monofilaments. Furthermore, all Synthetic Industries woven monofilament geotextiles exceed AASHTO M288-90 physical requirements for Class A and Class B subsurface drainage and erosion control geotextiles.

QUALITY

The Construction Products Division takes pride in the continued success of our geosynthetic products. This success stems from Synthetic Industries corporate dedication to quality; the quality of its people, its workplace, its customers, and most importantly, its products. Our strict MQA/MQC procedures specify rigorous, frequent testing to assure all of our geotextiles and other products meet/exceed our published property values.

Call us for information on:

- ▲ NONWOVEN GEOTEXTILES
- ▲ WOVEN SLIT FILM GEOTEXTILES
- ▲ LANDLOK® Turf Reinforcement Mats & Erosion Control and Revegetation Mats
- ▲ POLYJUTE® Inexpensive Open Weave Geotextile Erosion Protection
- ▲ LANDSTRAND® Erosion Control Roving Systems
- ▲ FIBERGRIDS® 3-Dimensional Soil Reinforcement Fibers for Civil Engineering Applications
- ▲ TURFGRIDS™ 3-Dimensional Soil Reinforcement Fibers for Athletic Surfaces.

CUSTOMER SERVICE

With the recent and rapid expansion of the Construction Products Division, one of our top priorities is providing the "customer" – distributor, engineer, or installer — with the best service available in the geosynthetic industry. We take pride in our ability to respond to technical questions and react in an ever changing marketplace. Call us at 1-800-621-0444.

MEMBERSHIP AFFILIATIONS INCLUDE:

GEOSYNTHETIC RESEARCH INSTITUTE

INTERNATIONAL EROSION CONTROL ASSOCIATION

IFAI

International geotextile society

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pg 5 of 5
DM 3/17/?

SYNTHETIC INDUSTRIES
CONSTRUCTION PRODUCTS DIVISION
"Smart Solutions in Synthetics"

Synthetic Industries Erosion III
Woven Monofilament Geotextile

Synthetic Industries Erosion III is a polypropylene, woven monofilament geotextile. The individual filaments are woven into a regular network and calandered such that the filaments retain dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. Synthetic Industries Erosion III conforms to the property values listed below:

PROPERTY VALUES	TEST METHOD	MINIMUM AVERAGE ROLL VALUES	
Mechanical		**English**	**Metric**
Grab Tensile Strength	ASTM D4632	360 x 260 lbs	1.60 x 1.16 kN
Grab Elongation	ASTM D4632	20 x 20 %	20 % x 20 %
Puncture Strength	ASTM D4833	140 lbs	0.62 kN
Mullen Burst	ASTM D3786	515 psi	3548 kPa
Trapezoidal Tear	ASTM D4533	100 x 60 lbs	0.44 x 0.27 kN
Hydraulic			
Percent Open Area (POA)	Lumite Method	5 %	5 %
Apparent Opening Size (AOS)	ASTM D4751	40 US Std. Sieve	0.425 mm
Permittivity, Ψ	ASTM D4491	0.30 sec^{-1}	0.30 sec^{-1}
Permeability, $k = \Psi \cdot t$	ASTM D4491	0.03 cm/sec	0.03 cm/sec
Water Flow Rate	ASTM D4491	30 gpm/ft^2	1220 $l/min/m^2$
Physical			
Weight	ASTM D3776	5.8 oz/sy	197 gr/m^2
Thickness, t	ASTM D1777	14 mils	0.36 mm
Endurance			
UV Resistance (% retained @ 500 hours)	ASTM D4355	90 %	90 %

Notes:

[1] Values shown are machine (warp) direction x cross-machine (fill) direction. Minimum average roll values represent a 95 percent confidence level, calculated as the mean minus two standard deviations.

Standard Roll Size Information: 6' x 300' = 200 sq. yds. 12' x 300' = 400 sq. yds.

 WMEIII-3-7.30.93

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

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PROJECT NO. ________

CLIENT ________

SUBJECT ________

Prepared By ______ Date ____

PROJECT ________

Reviewed By ______ Date ____

Approved By ______ Date ____

IV PIPE CRUSHING CALCS

CALCULATION SHEET

PROJECT NO. 72680.600

CLIENT ______ SUBJECT Pipe Crushing Calcs Prepared By TJL Date 1/30

PROJECT Skinner LF Reviewed By DM Date 3/12

Approved By ______ Date ______

OBJECTIVE :

TO DETERMINE THE MAXIMUM BURIAL DEPTH FOR A 2"-DIAMETER HDPE PIPE.

GIVEN :

- 2-IN HDPE PIPE
- SOIL PARAMETERS FROM FIELD INVESTIGATION

ASSUMPTIONS :

- SOIL UNIT WEIGHT = 125 pcf
- DRISCOPIPE - 2" DIA. SDR 11 OR EQUIVALENT WILL BE USED.
- ANY SURFACE LOAD APPLIED WILL BE OF NEGLIGIBLE EFFECT.
- PIPE SYSTEM IS A PRESSURIZED PIPELINE
- 90% OF STANDARD PROCTOR COMPACTION WILL BE REQUIRED FOR BACKFILL
- A MINIMUM 2.0 FACTOR OF SAFETY
- INITIAL BACKFILL WILL BE MATERIAL CLASS III - COARSE GRAINED w/FINES ✓

CALCULATION SHEET

PROJECT NO. 72680600

CLIENT ____

SUBJECT PIPE CRUSHING CALC

PROJECT SKINNER LF

Prepared By TJC Date 1/30

Reviewed By DM Date 3/2

Approved By ____ Date ____

PROCEDURE:

1.) USING THE SIMPLIFIED BURIAL DESIGN (PAGE 4 of 4) CHOOSE A STARTING DEPTH TO EVALUATE.

2.) CHECK PIPE AGAINST WALL CRUSHING, USING A COMPRESSIVE YIELD STRENGTH OF 1500 psi FOR DRISCO PIPE, AND THE EQUATION:

$$S_A = \frac{(SDR - 1)}{2} P_T$$

WHERE:

S_A = ACTUAL COMPRESSIVE STRESS, psi

SDR = STANDARD DIMENSION RATIO

P_T = EXTERNAL PRESSURE, psi

REFERENCES:

1.) PHILLIPS 66 DRISCOPIPE SYSTEMS DESIGN

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO. 72680.600

CLIENT ______ SUBJECT Pipe Crushing Calc

Prepared By TJC Date 1/30

PROJECT Skinner LF

Reviewed By DM Date 3/12

Approved By ______ Date ______

CHECK AGAINST WALL CRUSHING

ASSUME DEPTH OF 35 FT. (CONSERVATIVE) ACTUAL DEPTH ≈ 9'

$$S_A = \frac{(SDR - 1)}{2} P_T$$

WHERE : S_A = ACTUAL COMPRESSIVE STRESS, psi
SDR = STANDARD DIMENSION RATIO
P_T = EXTERNAL PRESSURE, psi

$$P_T = \text{depth} (\gamma)$$
$$= 35 \text{ ft} (125 \text{ pcf}) = 4375 \text{ psf}$$
$$= 4375 \text{ psf} \left(\frac{ft^2}{144 in^2}\right) = 30.38 \text{ psi}$$

$$S_A = \frac{(11-1)}{2}(30.38) = 151.9 \text{ psi}$$

$$\text{FACTOR OF SAFETY} = \frac{1500 \text{ psi}}{S_A}$$

WHERE : 1500 psi = COMPRESSIVE YIELD STRENGTH OF DRISCO PIPE

$$F.S. = \frac{1500}{151.9} = \underline{\underline{9.8}}$$ WHICH IS GREATER THAN 2.0

TO DETERMINE MAXIMUM DEPTH ~~THICKNESS~~ :

$$F.S. = 2.0 = \frac{1500}{S_A} \qquad S_A = \frac{1500}{2} = 750 \text{ psi}$$

$$P_T = \frac{2 S_A}{(SDR-1)} = \frac{2(750)}{(11-1)} = 150 \text{ psi}$$

$$\text{DEPTH} = \frac{P_T}{\gamma} = \frac{150 \text{ psi}\left(\frac{144 in^2}{ft^2}\right)}{125 \text{ pcf}} = \underline{\underline{172.8 \text{ ft}}}$$

Pg 4 of 4
TSL 1/30
3/12/92

Simplified Burial Design: A conservative estimate of the ability of Driscopipe pipelines to perform in a buried environment is found in Chart 24. It is based on a minimum 2:1 safety factor and 50 year design service life. A detailed burial design starts on page 37. The detailed design should be used for critical or marginal applications or whenever a more precise solution is desired.

Detailed Burial Design:
Design by Wall Crushing: Wall crushing would theoretically occur when the stress in a pipe wall, due to the external vertical pressure, exceeded the long-term compressive strength of the pipe material. To ensure that the Driscopipe wall is strong enough to endure the external pressure the following check should be made:

$$S_A = \frac{(SDR - 1)}{2} P_T$$

Values of E′

Based on Soil Type (ASTM D2321) and Degree of Compaction

Soil Type of Initial Backfill Embedment Material	Description	E′ (psi) for Degree of Compaction (Proctor Density, %) Loose	Slight (70-85%)	Moderate (85-95%)	High (95%)
I	Manufactured angular, granular materials (crushed stone or rock, broken coral, cinders, etc.)	1,000	3,000	3,000	3,000
II	Coarse grained soils with little or no fines	N.R.	1,000	2,000	3,000
III	Coarse grained soils with fines	N.R.	N.R.	1.000	2,000
IV	Fine-grained soils	N.R.	N.R.	N.R.	N.R.
V	Organic soils (peat, muck, clay, etc.)	N.R.	N.R.	N.R.	N.R.

N.R. = Not Recommended for use by ASTM D2321 for pipe wall support

Chart 24

SDR	Maximum Burial Depth, ft. in dry soil of 100 lbs/cu. ft. Soil Modulus, psi*			Maximum External Pressure psi Soil Modulus, psi*			Maximum Deflection, % after installation Soil Modulus, psi*		
	1000	2000	3000	1000	2000	3000	1000	2000	3000
32.5	25	32	37	17	22	26	1.7	0.9	0.6
26	33	45	52	23	31	36	2.3	1.2	0.8
21	46	61	71	32	42	49	3.2	1.6	1.1
19	52	69	81	36	48	56	3.6	1.8	1.2
17	61	121	181	42	84	126	4.2	2.1	1.4
15.5	56	112	168	39	78	117	3.9	2.0	1.3
13.5	49	98	147	34	68	102	3.4	1.7	1.1
11	39	78	117	27	54	81	2.7	1.4	0.9
9.3	33	68	101	23	47	70	2.3	1.2	0.8
8.3	30	61	89	21	42	62	2.1	1.1	0.7
7.3	26	52	79	18	36	55	1.8	0.9	0.6

*assumes no external loads

RUST ENVIRONMENT & INFRASTRUCTURE

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____ ____ Approved By ____ Date ____

V GRANULAR DRAINAGE MAT'L

SELECTION

CALS

RUST **Rust Environment & Infrastructure**

	CALCULATION SHEET	PAGE 1 OF 2
		PROJECT NO. 72680.500
CLIENT	SUBJECT ~~DITCH~~ TRENCH GRANULAR FILTER SIZE	Prepared By TJC Date 1/31
PROJECT SKINNER LF		Reviewed By DM Date 3/12
		Approved By Date

OBJECTIVE:

DETERMINE MINIMUM PARTICLE SIZE NEEDED IN TRENCH FILTER MATERIAL TO OBTAIN A PERMEABILITY OF 1×10^{-2} cm/sec OR GREATER.

CONCLUSION:

A D_5 of 0.2 mm OR LARGER (MEDIUM GRAINED SAND TO GRAVEL) WILL HAVE THE DESIRED 1×10^{-2} cm/sec OR GREATER PERMEABILITY.

REFERENCES:

1.) DAS, BRAJA M., "PRINCIPLES OF GEOTECHNICAL ENGINEERING", THIRD EDITION, 1994, pgs 141-143.

Pg 2 of 2

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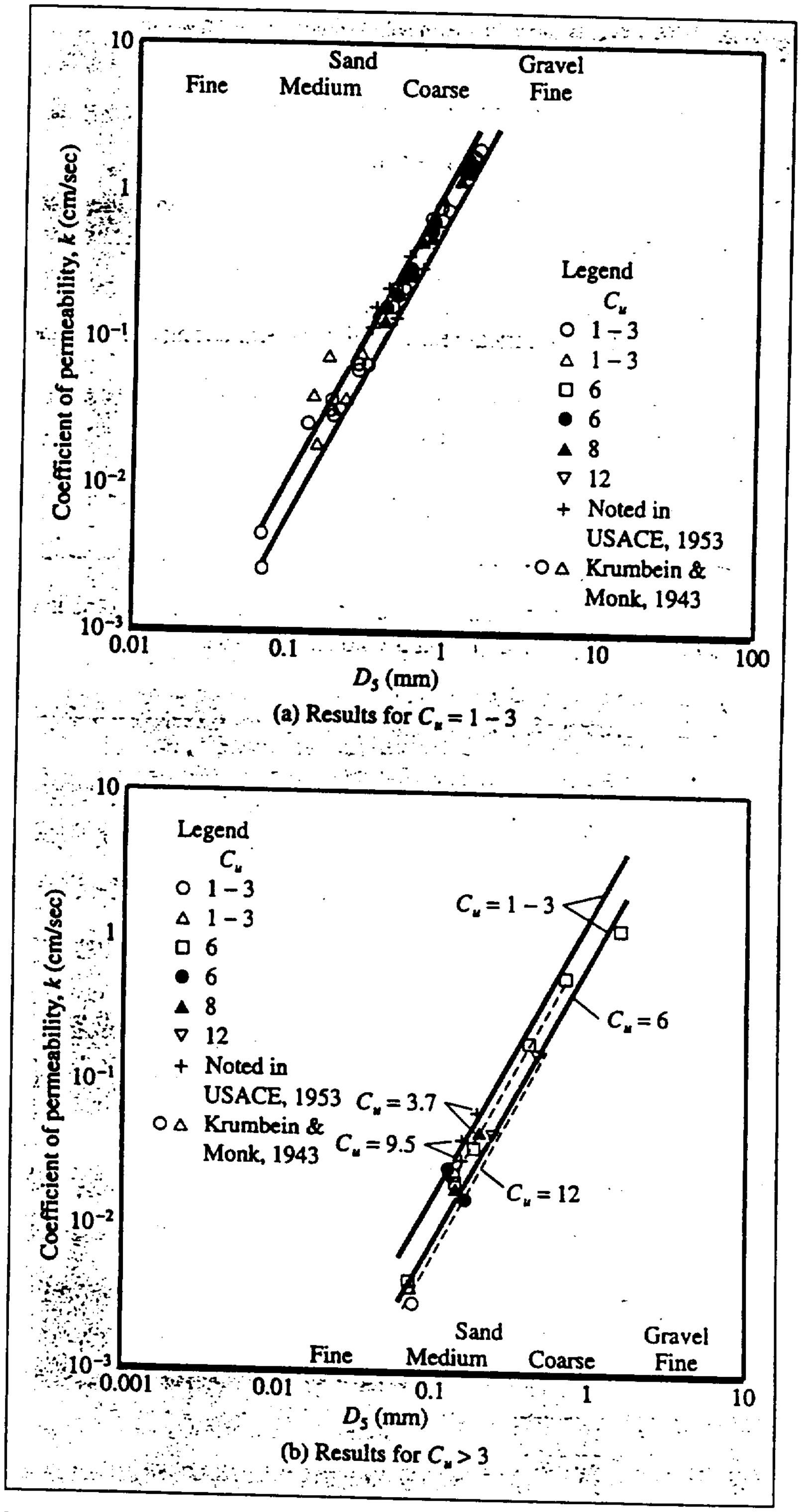

FIGURE 5.9 Results of permeability tests on which Eq. (5.27) is based (after Kenny, Lau, and Ofoegbu, 1984)

[REF. # 1]

SKINNER LANDFILL
REMEDIAL DESIGN
FINAL DESIGN (100%) PHASE I REPORT

VOLUME I OF IV

THE FOLLOWING MAPS MAY BE VIEWED AT THE U.S. EPA RECORD CENTER, 77 WEST JACKSON BLVD., 7TH FLOOR, CHICAGO, ILLINOIS

1) GROUNDWATER INTERCEPTION/COLLECTION DESIGN
2) EXISTING CONDITIONS
3) GWDI PLAN & PROFILE
4) UTILITY TRENCH PLAN
5) SITE PREPARATION
6) TRENCH PLAN AND PROFILE
7) FORCE MAIN PLAN & PROFILE
8) MISCELLANEOUS UTILITY DETAILS
9) SITE PREPARATION DETAILS
10) TRENCH & EXCAVATION DETAILS
11) FORCE MAIN DETAILS - 1
12) FORCE MAIN DETAILS - 2
13) FORCE MAIN DETAILS - 3